Masonry & Metal

The Historic Bridges of Bergen County, New Jersey

Prepared by
Richard Grubb & Associates, Inc.

for
Pickering, Corts & Summerson
and
Bergen County Department of Public Works, Engineering Office

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Prepared by

Jennifer B. Leynes
Senior Architectural Historian
Richard Grubb & Associates, Inc.
30 North Main Street
Cranbury, New Jersey 08512

for

Pickering Corts & Summerson
828B Newtown-Yardley Road
Newtown, Pennsylvania 18940

and

Bergen County Department of Public Works
Engineering Office
One Bergen County Plaza, Floor 4
Hackensack, New Jersey 07601

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Project Information:

This publication was prepared by Richard Grubb & Associates, Inc., on behalf of the Bergen County Department of Public Works, Engineering Office. In 1999, the Department prepared a Historic Bridge Alternatives Analysis (HBAA) for the Lake Avenue Bridge in Midland Park, which previously had been determined eligible for the National Register of Historic Places by the State Historic Preservation Officer (SHPO). The HBAA determined that replacement of the structurally deficient and functionally obsolete bridge was the best alternative. The SHPO concurred with this assessment but required the documentation of the bridge to Historic American Engineering Record (HAER) standards prior to its demolition; as additional mitigation for the loss of the historic bridge, the Department agreed to publish a brochure describing the historic bridges of Bergen County. The project was completed under contract to Pickering, Corts & Summerson, Inc., of Newtown, Pennsylvania.

Introduction

Bridges have been integral to the history of Bergen County, New Jersey, since the arrival of the first Dutch settlers in the early seventeenth century. Spanning the county's many rivers, streams, and brooks, bridges opened new areas to settlement and later formed conduits for the suburbanization of the county. From the earliest timber structures to late nineteenth-century iron trusses and modern concrete spans, Bergen County's bridges illustrate the evolution of bridge building technology in New Jersey.

The earliest bridges in Bergen County were simple wooden and masonry structures, none of which have survived to the present. In fact, the oldest bridge still standing in Bergen County today is believed to be a brick arch in Demarest, carrying Hardenburgh Avenue over Tenakill Brook, built around 1875. This structure, as well as a number of metal truss bridges, reinforced concrete arches, and movable spans, are among the county's surviving technologically significant bridges.

(1)
Hardenburgh Avenue Bridge
Demarest
Built circa 1875

When the New Jersey Department of Transportation completed its statewide survey of historic bridges in 1994, eighteen technologically significant structures were identified in Bergen County. Additionally, eight historic bridges over the Passaic River—the county line between Essex to the south and Passaic to the north—were also identified in the survey. All of these significant structures were determined eligible for the National Register of Historic Places by the New Jersey State Historic Preservation Officer.

Despite the variety and character of Bergen County's historic bridges, these structures are disappearing from the local landscape, victims of time and the demands of modern vehicular traffic. Since the completion of the statewide bridge survey, nearly one-third of Bergen County's historic bridges have been demolished or moved from their original locations.

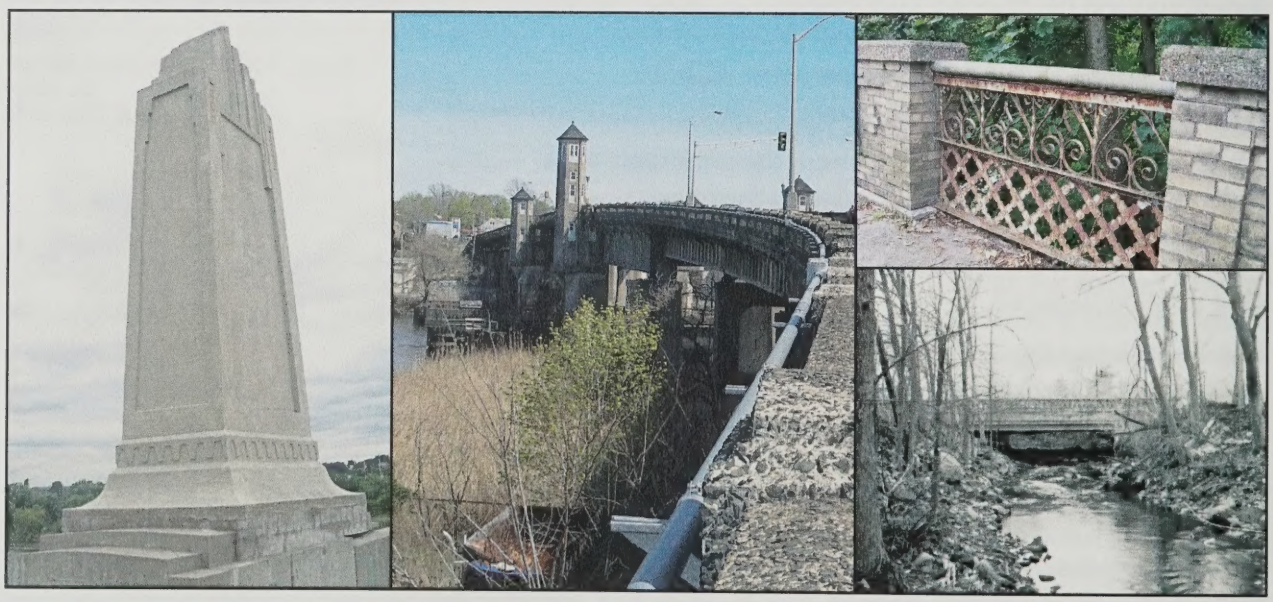
This booklet highlights Bergen County's technologically significant bridges, with a focus on spans carrying state and county roadways. Railroad structures have been omitted from this survey; although significant bridges built to carry the county's many rail lines during the nineteenth and twentieth centuries survive, they represent a distinctive type and are deserving of a separate treatment. In addition to the descriptions and photographs of Bergen County's remaining technologically significant bridges, this booklet also contains an overview of the county's transportation history and general information about the various bridge types found in the county.

The National Register of Historic Places is a list of buildings, structures, districts, sites, and objects with significance in the areas of history, architecture, engineering or archaeology.

The bridges selected for inclusion in this brochure represent all of the extant structures identified in the 1994 New Jersey Historic Bridge Survey as technologically significant and therefore eligible for inclusion in the New Jersey and National Register of Historic Places. Although it no longer carries vehicular traffic, New Bridge, at New Bridge Landing, River Edge, is also included as a significant structure that is individually listed on the New Jersey and National Registers. The George Washington Bridge is also described herein, both because of its technological significance and the impact of its construction on transportation in Bergen County.

(12)
New Bridge
River Edge
Built 1895

The historic bridges of Bergen County are grouped according to type, with sections dedicated to masonry arches, metal trusses, metal girders, and movable spans. The one exception is the George Washington Bridge and its approaches, which are treated separately, in part because their significance is derived from their relationships to each other. The four bridge types are explained in general terms and followed by descriptions and photographs of the representative historic structures in Bergen County. Each of the historic bridges has been assigned a unique number, found beneath the photo; this number is keyed to a county map at the center of the brochure showing the locations of all of Bergen's historic bridges.



From left: pylon, US Route 46 Bridge over Passaic River, Elmwood Park to Paterson (6); US Route 46 Bridge over Hackensack River, Little Ferry (17); detail of railing, East Ridgewood Avenue Bridge, Ridgewood (5); Lake Avenue Bridge, Midland Park (2)

Transportation in Bergen County

The first settlers in Bergen County—which until 1840 included portions of Hudson and Essex Counties—primarily used the area's rivers and streams for transportation during the colonial period. When overland travel was necessary, settlers utilized the existing paths and trails created by Native Americans to explore inland areas. These paths typically followed winding routes and were only wide enough for a single person or horse to pass. Improving these early trails was a priority for the colonial legislature, which created the county's first Road Board in 1683; nevertheless, road building proceeded slowly during the colonial period.

Most of Bergen County's early roads led to ferries on the Hudson River, which provided a vital link to the urban center of New York City. By the early eighteenth century, five ferries were operating between New Jersey and New York City. Within the county, ferry service was also established across the Hackensack and Passaic Rivers during this early period. These rivers formed natural barriers to westward settlement and, as a result, attracted early bridge-building efforts by local officials. These early bridges were typically financed by the town or county, although officials occasionally held lotteries to raise the needed funds.

One of the earliest spans in Bergen County, known as New Bridge, was built over the Hackensack River around 1744. This wooden movable bridge was the first of several to be built at this location during the eighteenth and nineteenth centuries. Another prominent early movable span located downstream from New Bridge was in the City of Hackensack, at the site of the existing Court Street Bridge. The county later built movable bridges at both of these important crossings.

Detail from 1776 Map Showing Old Bridge and New Bridge from Geography and Map Division, Library of Congress

In 1784, a group of contractors incorporated as "The Proprietors of the Bridges over the Rivers Passaic and Hackensack" and claimed exclusive rights to building bridges across both rivers. They completed the bridges in 1795, providing a vital link between Jersey City and Newark. Private investment through subscription was also used to build other local bridges during the early nineteenth century.

Around the same time, investors also began incorporating the first turnpike companies in New Jersey. In Bergen County, numerous toll roads were built during the early nineteenth century, opening new east-west routes across the state. The most important routes included the Bergen Turnpike, Paterson-Hamburg Turnpike,

Hackensack and Fort Lee Turnpike, Franklin Turnpike, and Paterson and New York Plank Road. The turnpikes were soon surpassed in popularity by canals and railroads; however, these early roadways remained important for local travel and later became the basis for the state highway system.

In 1831, the New Jersey Legislature chartered the Paterson and Hudson River Railroad, the first in Bergen County. In the decades that followed, six other rail lines were built in the county, opening their routes to new development. The local population expanded accordingly, and new commuter suburbs soon grew up around the railroad stations. Resort communities, including Fort Lee, Edgewater, and Park Ridge, also developed near the rail lines. This development in formerly rural and agricultural areas heightened pressure on the existing network of local roads, prompting the county's Board of Freeholders to seize control of all road and bridge building and maintenance from local municipalities in 1889. The Freeholders created the position of County Engineer in 1907 to supervise construction and maintenance of roads, bridges, storm sewers, and drains.

(9)
Warren Avenue Bridge
Ho-Ho-Kus
Built 1895

The suburbanization of Bergen County accelerated during the early twentieth century with the emergence of the automobile as an affordable and increasingly popular means of transportation. As a result, new roads were needed to handle the growth. In addition to the county's road-building efforts, both the federal and state governments also contributed to the development of the area's highway system. The Port of New York Authority, predecessor to the modern Port Authority of New York and New Jersey, also played a key role in transportation planning throughout the region after its creation in 1921. The Holland Tunnel, George Washington Bridge, and Lincoln Tunnel improved access between New Jersey and New York and required development of access roads, ramps, and bridges to facilitate traffic flow.

The construction of the George Washington Bridge across the Hudson River from Manhattan to Fort Lee fostered Bergen County's growth in the mid-twentieth century. The bridge was an engineering feat: its 3,500-foot main span was twice as long as any other existing suspension bridge built at that time. Constructed over four years at a cost of $59 million, the bridge opened in 1931 to great fanfare.

In Bergen County, the George Washington Bridge had a significant impact on local road systems, as engineers had to devise access routes leading to and from the new span for both local and through traffic. Many of Bergen County's bridges were built during the period 1928-1936 and were associated with the George Washington Bridge

approaches or the highways that carried traffic onto and off of the bridge.

The George Washington Bridge spurred another period of roadway development during the early 1960s, when the lower deck was added. Part of the original plans for the bridge, the addition of the lower deck required construction of new approach roads on both sides of the Hudson River, including the Bergen-Passaic Expressway (present-day I-80) in New Jersey. The lower deck and its approach roadways were completed in 1962.

George Washington Bridge,
Fort Lee to New York City
Built 1931

Bridge Building in Bergen County

The Bergen County Board of Chosen Freeholders assumed responsibility for the county's roads and bridges in the late nineteenth century. Despite an initial fight for funding between the rural communities in the western part of the county and the populous urban areas in the east, the consolidation of road building under the direction of the Freeholders was a positive force for transportation planning throughout the county. The creation of the position of County Engineer in 1907 further enhanced the county's road and bridge building program in the early twentieth century.

(2)
Concrete parapet
Lake Avenue Bridge
Midland Park
Built 1897
Parapet constructed 1931

After taking control of road and bridge building, the Freeholders approved construction of a variety of bridge types in Bergen County. This variety reflects the unique requirements of each bridge site: the distance to be spanned by the structure, the amount of clearance needed beneath the bridge, and the relative cost of the available bridge types were all factors considered in bridge type selection.

State and national trends also played a role in Freeholders' decision making, particularly as new materials and designs emerged in the late nineteenth and early twentieth century. Brick arches were waning in popularity by 1889, when the Freeholders assumed responsibility for bridge building in the county; these masonry structures were soon supplanted by metal truss and girder structures. Advancements in concrete technology—in particular, the introduction of concrete reinforced with steel bars—eventually led to a preference for structures built of this material.

In addition to the bridges built at the direction of the Freeholders, Bergen County also contains numerous bridges built by the New

Jersey State Highway Department, predecessor to the modern New Jersey Department of Transportation. The Department was established to oversee development of the state highway system, which was created by the New Jersey legislature in 1916 and initially included sixteen highways. Only one of these—Route 10, which extended from Paterson to the Fort Lee Ferry, following portions of the old Bergen Turnpike—passed through Bergen County. The state highway system expanded rapidly in the 1920s and 1930s to include additional routes through Bergen County; many of these highways were designed to improve access to the George Washington Bridge. The bridges built by the Department were generally larger in size and scale than those built by the county, and almost all were reinforced concrete construction.

Masonry Arch Bridges

Although stone arch bridges were built in New Jersey during the colonial period, they were relatively uncommon because of the cost and labor involved in their construction, and it is not known whether any stone arch bridges were built in Bergen County. During the 1870s and 1880s, brick arch bridges became popular, in part because of technological improvements to bricks and the cement mortar used to bond them together. Easier to construct than their stone counterparts, brick arch bridges are created with several layers of mortared brick built around a temporary wooden frame, known as falsework. Earth and rubble fill is then placed above the arch. Brick arch bridges of this period were typically finished with stone masonry on the walls adjacent to the arch (spandrels) and the walls rising above the roadway (parapets). Only one highway bridge of this type, the Hardenburgh Avenue Bridge (1), remains in Bergen County.

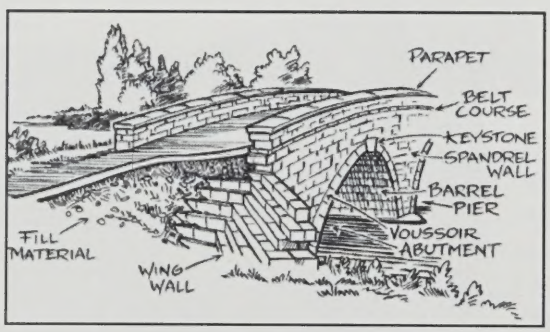


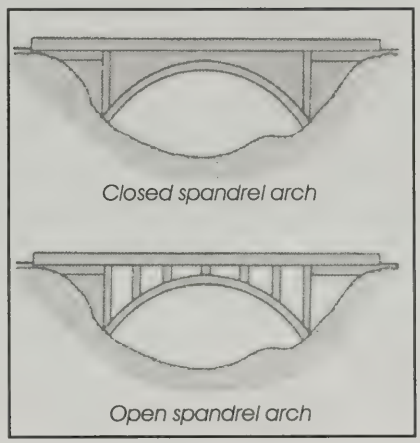
Diagram of an arch bridge from Research/Penn State *September 1998*

Around the turn of the twentieth century, brick arch bridges were surpassed in popularity both by metal truss bridges and by arched structures built with steel and concrete. From the 1890s through the 1910s, the Bergen County Freeholders commissioned many of these arched structures throughout the county. These bridges, which often employed decorative detailing, were popular in part because of their aesthetic qualities, which fit gracefully into the suburban communities of Bergen County. The New Jersey Historic Bridge Survey noted that the county's arch bridges were "the most unusual and noteworthy of any county in the state."

In addition to their aesthetic appeal, many of Bergen's steel and concrete arch bridges represent significant technologies of the period. The reinforced concrete bridges, in particular, demonstrate advances in the use of concrete in construction. Much of this technology was

developed in Europe during the mid-nineteenth century; however, reinforced concrete was not widely used in the United States until the 1880s. Three technologically significant types of reinforced concrete were developed and applied to the construction of arch bridges:

- *Melan* arches were developed by Austrian engineer Josef Melan. Melan arches are in essence metal arches encased in concrete. The Wyckoff Avenue Bridge (3) and the East Ridgewood Avenue Bridge (5) are representative examples of Melan arches.
- *Monier* arches employ wire mesh nets embedded in the concrete as reinforcement. The system is named after its designer, Jean Monier, of France. The Colonial Road Bridge (4) is one of only three known Monier arch bridges in Bergen County.
- *Ransome* reinforcing systems employ metal bars distributed in the tension zones of the arch. Developed by American Ernest Ransome in the 1880s, this system of metal reinforcing rods embedded in concrete became the dominant system used for all types of concrete construction by the early twentieth century. Despite its popularity, none of the historic bridges in Bergen County employ the Ramsome reinforcing system.



Types of arch bridges from Historic Bridge Foundation

Until the early twentieth century, all arch bridges were closed spandrels; that is, the area around the arch was filled. Engineers developed the open spandrel arch as an alternative form capable of spanning much longer distances with fewer materials, combining the tensile strength of steel reinforcing with the compressive ability of concrete to advantage. The resulting design creates a graceful yet powerful structure. The first open spandrel arch bridges in New Jersey were railroad structures, but the State Highway Department began building the structures on roadways in 1929. Led by Chief Bridge Engineer Morris Goodkind, the department constructed six open spandrel arches in northeastern New Jersey prior to World War II, including the US Route 46 Bridge over the Passaic River (6).

(1)

Hardenburgh Avenue Bridge
over Tenakill Brook
Demarest Borough
Built circa 1875

Listed on the National Register of Historic Places, the Hardenburgh Avenue Bridge is a brick arch structure built circa 1875. The bridge was widened in 1911 using steel stringers and concrete jack arches. The combined use of the brick arch with the stringer and jack arch construction is believed to be unique in New Jersey.

The Hardenburgh Avenue Bridge is significant as a well-preserved example of an uncommon bridge type. The iron railings installed when the bridge was widened in 1911 were later replaced with stone parapet walls. In 1999, Bergen County rehabilitated the bridge with a grant from the New Jersey Historic Trust. The bridge was strengthened and new concrete parapets were built and faced with the original stone.

(2)

Lake Avenue Bridge
over Goffle Brook
Midland Park Borough
Built 1897

The Lake Avenue Bridge combines two significant technologies, the steel arch and the brick jack arch. The brick jack arches span the area between six arched I-beams, which function as ribs between the jack arches. The bridge was built by the F.R. Long Company, which was founded by bridge engineer Frank Rowland Long of Hackensack. The firm built numerous bridges in northern New Jersey, including several spans still standing in Bergen County. The F.R. Long Company's headquarters and production facility were located adjacent to the Court Street Bridge in Hackensack (15).

This bridge is significant as the only known highway bridge in New Jersey to employ steel arch and brick jack arch construction. It is also significant for its associations with the F.R. Long Company, a regionally significant bridge-building firm and one of the few operating in Bergen County.

The Lake Avenue Bridge was widened in 1931 to provide sidewalks; at that time, the original decorative railing was removed and the existing concrete parapets constructed. Scheduled for replacement

in 2009, it was documented in a Historic American Engineering Record (HAER) report, which is available at the New Jersey State Historic Preservation Office in Trenton and several local repositories.

Wyckoff Avenue Bridge
over Ho-Ho-Kus Brook
Wyckoff Township
Built 1899

(3)

This Melan reinforced concrete arch bridge carries Wyckoff Avenue over the Ho-Ho-Kus Brook. It was built in 1899 using a design patented by the firm of Keepers and Thacher Engineers, which maintained an office in Paterson. Edwin Thacher, one of the firm's principals, held patents for several truss and reinforced concrete arch designs. Keepers and Thacher were responsible for a number of technologically significant bridges in the United States, including a concrete and steel arch over the Kansas River in Topeka, which was the largest of its type when built. Locally, the firm also built the Broadway Street Bridge over the Passaic River in Paterson.

The Wyckoff Avenue Bridge is significant as a rare surviving example of a Melan arch bridge and for its associations with designers Keepers and Thacher. It was widened on both sides in 1958 with concrete slabs and parapets.

Colonial Road Bridge
over Tributary of Pond Brook
Franklin Lakes Borough
Built 1902

(4)

The Colonial Road Bridge, which spans a tributary of Pond Brook, was built in 1902. The bridge is an elliptical concrete arch structure that employs the Monier system of concrete reinforcement.

The Colonial Road Bridge is believed to be one of only three Monier arch bridges in Bergen County and is significant as an example of a concrete arch bridge with a documented patented reinforcement system. The bridge was widened on both sides in 1930, and the sidewalks and parapets were added at that time. The structure was rehabilitated by the county in 2001.

(5)

East Ridgewood Avenue Bridge
over Ho-Ho-Kus Brook
Ridgewood Village
Built circa 1904

The East Ridgewood Avenue bridge is an elliptical reinforced concrete structure spanning Ho-Ho-Kus Brook. The bridge is a Melan arch; although two other similar bridges were built in Bergen County during the early twentieth century, this structure is the best example of its type. The detailing on the bridge, including brick and stone facing and decorative metal railings, is uncommon in New Jersey.

The bridge derives its significance both from its decorative detailing and as an intact surviving example of a Melan arch structure.

(6)

US Route 46 Bridge
over the Passaic River
Elmwood Park Borough &
City of Paterson
Built 1937

This bridge carries US Route 46 over the Passaic River, which serves as the boundary between Bergen and Passaic Counties. The bridge is a five-span open spandrel arch, a type that was developed using reinforced concrete technology in the early twentieth century. The open spandrel design was a significant advancement because it lightened the load of the concrete arch, making it usable over longer distances; it also offered a graceful, aesthetic alternative for large highway bridges.

The US Route 46 Bridge over the Passaic was built in 1937 and was designed by Morris Goodkind, the Chief Bridge Engineer for the State Highway Department from 1925 to 1955. Goodkind was influential in creating highway bridges that were both functional and aesthetically pleasing; as a result, many of the bridges built by the State Highway Department prior to World War II employed Art Deco and Art Moderne design elements.

The bridge is significant both as an example of the open spandrel design and for its association with Goodkind. The structure originally had an open balustrade, but in 1998 it was replaced by the existing concrete parapet. The deck was replaced and the bridge widened at the same time, but the original open spandrel arch substructure remains.

Truss Bridges

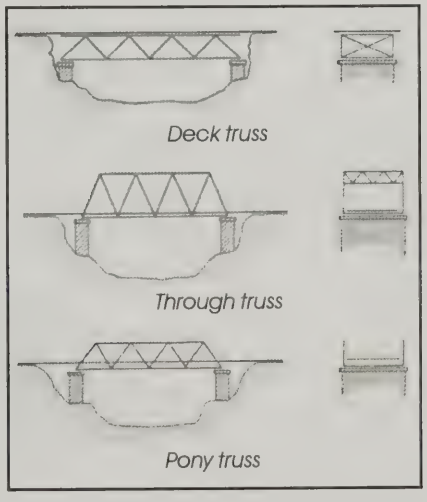
During the last decades of the nineteenth century, metal truss bridges surpassed wood and brick structures in popularity in Bergen County and throughout New Jersey. A truss bridge is constructed of many individual pieces, known as members, acting in tension or compression to perform together as a unit. The members are usually arranged in a repeated triangular pattern because the shape is resistant to stress. Railroads developed metal truss bridge technology after the Civil War to accommodate the large live loads of locomotives and freight; this technology was soon adapted for use on local roadways.

The earliest remaining metal truss bridge in Bergen County dates to 1888, but the county likely began building truss bridges at least a decade earlier. When the Freeholders determined that a truss bridge was desirable for a site, they solicited bids from bridge building firms; these firms fabricated the bridges in sections at their factories, transporting them by rail to the bridge site. The bridges were then assembled on stone abutments built by local masons.

Most early metal truss bridges were constructed of cast iron, formed by pouring molten iron into molds, or wrought iron, which gained popularity as a more malleable and less brittle alternative to cast iron. These earlier truss bridges typically had pinned connections, in which large metal pins were inserted through holes drilled in the ends of the members during erection of the bridge. Although pinned connections were not as rigid as riveted connections, the pins were much easier and more economical to use at bridge sites. In the 1890s, steel surpassed iron in popularity for bridge construction, and riveted connections became increasingly common due to improvements to pneumatic riveting equipment, which made the process more practical and affordable for construction on site.

All truss bridges can be classified as a deck, pony, or through truss. A deck truss is one in which the roadway is carried on top of the structure. Both the pony truss and the through truss carry traffic between the parallel superstructures; however, the through truss has cross bracing at the top, over the roadway, while the pony truss does not. While the triangle is the basic form of all truss bridges, a number of distinctive types were developed by engineers. The surviving truss bridges in Bergen County are of three types:

- *Pratt* truss bridges employ diagonals between the vertical members to form its characteristic V-shape. Developed by Thomas and Caleb Pratt in 1844, these structures often have crossing diagonal members in the center section. The Elm Street (8), Warren Avenue (9), and Fair Lawn Avenue (10) Bridges are all historic Pratt trusses.

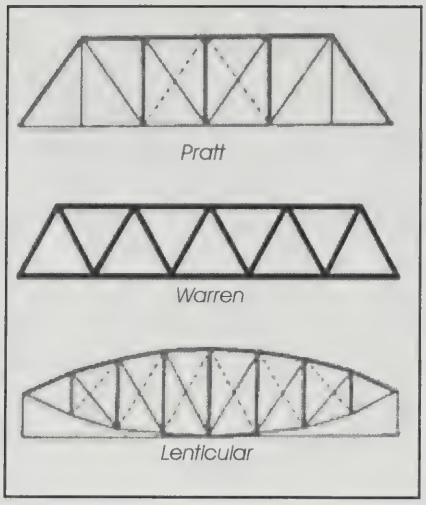


Types of metal bridge construction from Historic Bridge Foundation

KEY

1. Hardenburgh Avenue Bridge
2. Lake Avenue Bridge
3. Wyckoff Avenue Bridge
4. Colonial Road Bridge
5. East Ridgewood Avenue Bridge
6. US Route 46 Bridge
7. Cleveland Bridge
8. Elm Street Bridge
9. Warren Avenue Bridge
10. Fairlawn Avenue Bridge
11. Passaic Avenue Bridge
12. New Bridge
13. De Jessa Memorial Bridge
14. Slomiany Memorial Bridge
15. Dillard Memorial Bridge
16. 8th Street Bridge
17. US Route 46 Bridge
18. NJ Route 3 Bridge
19. NJ Route 4 Bridge

Historic Bridges of Bergen County, New Jersey



Truss types
from Historic Bridge Foundation

- *Warren* trusses are composed of either equilateral or isoceles triangles connecting the top and bottom chords; these triangles are sometimes subdivided. The Warren truss was patented by its designers, James Warren and Willoughby Monzoni, in 1848. Several of the county's movable spans employ Warren trusses, including the De Jessa Memorial Bridge (13), Dillard Memorial Bridge (15), and 8th Street Bridge (16).
- *Lenticular* truss bridges take their name from their characteristic lens shape, which is achieved with opposing arches. Developed in 1865 by Friedrich August von Pauli, the lenticular truss is known for its flexibility, which is sometimes felt by vehicular traffic. The Cleveland Bridge (7) is the only historic lenticular truss in Bergen County.

(7)

Cleveland Bridge
Bear Swamp Road
over the Ramapo River
Mahwah Township
Built 1888

The Cleveland Bridge, as this structure over the Ramapo River is known, was built by the Berlin Iron Bridge Company of East Berlin, Connecticut, in 1888. This company was one of the most prolific bridge building firms in the Northeastern United States and was best known for its lenticular trusses, for which it received a patent in 1878. According to a historical marker adjacent to the bridge, the structure was named in honor of President Grover Cleveland and replaced an earlier wood structure at this location.

The Cleveland Bridge is significant as a rare example of an uncommon bridge type, the lenticular truss, and as the oldest surviving structure built by the Berlin Iron Bridge Company in New Jersey. The Cleveland Bridge is one of only two bridges to survive the severe 1903 flooding of the Ramapo River.

Elm Street Bridge
over the Hackensack River
Oradell Borough
Built 1892

(8)

The Elm Street Bridge is a wrought-iron, Pratt pony truss structure built in 1892. The bridge is one of only three pony truss bridges in New Jersey that employs Phoenix Column construction, a significant technological innovation that contributed to the popularity of iron truss bridges in the 1870s. The Phoenix Column was comprised of four riveted wrought-iron channel sections and was much stronger than the cast iron members previously used in bridge construction. Invented by Samuel J. Reeves of the Phoenix Iron Company, Phoenixville, Pennsylvania, the Phoenix Column was used until the early 1890s, when the built-up box supplanted it in popularity.

The bridge is significant as a rare example of Phoenix Column construction. The sidewalk was added to the bridge in 1964.

Warren Avenue Bridge
over Ho-Ho-Kus Brook
Ho-Ho-Kus Borough
Built 1895

(9)

This Pratt through truss bridge carries Warren Avenue over a high ravine above Ho-Ho-Kus Brook. Originally built in 1895 as a railroad bridge in Narrowsburg, New York, the Erie Railroad moved this structure to Ho-Ho-Kus around 1908 to improve access to its station at Brookside Avenue and 1st Street. The bridge was adapted for highway use at its new location.

The Warren Avenue Bridge is significant as an excellent example of a surviving Pratt through truss span in Bergen County.

(10)

Fair Lawn Avenue Bridge
over the Passaic River
Fair Lawn Borough &
City of Paterson
Built 1905

This bridge carries Fair Lawn Avenue over the Passaic River, the boundary between Bergen and Passaic Counties. The two-span, Pratt through truss was built in 1905 to replace an earlier structure destroyed in the severe flooding of the Passaic River in October 1903. It has both pinned and riveted connections, demonstrating the transition between the two technologies around the turn of the century. The decorative lattice railings, which are accented with rosette bosses, are among the bridge's significant features.

The Fair Lawn Avenue Bridge is significant as a well-preserved, uncommon bridge type in Bergen and Passaic Counties.

Clockwise from top: Elm Street Bridge, Oradell (8); historical marker, Cleveland Bridge, Mahwah (7); Warren Avenue Bridge, Ho-Ho-Kus (9); detail of railing, Fair Lawn Avenue Bridge, Fair Lawn to Paterson (10)

Metal Girder Bridges

At the same time that metal truss bridges were being developed, engineers also began to develop metal girder bridges. A girder refers to a beam used as a horizontal support for a bridge; a girder bridge is built of these horizontal supports, which are placed on the bridge abutments and, if necessary, piers placed between the abutments. The bridge deck is then constructed on top of or between the girders. When the bridge deck is located atop the girders, the structure is referred to as a deck girder, and when it is between the girders, it is known as a through girder.

(11)
Detail of metal plate girder
Passaic Avenue Bridge
Garfield and Passaic
Built 1898

Several subtypes exist. The earliest and simplest girder bridges are built of rolled I-beams, which are produced at a steel mill. Because of physical limitations inherent in the production process, the height of the girders—and thus their strength—is limited. As a result, the length of the bridge is also limited to less than 100 feet. Plate girders, on the other hand, are comprised of flat metal sections that are riveted or welded to create an I-beam shape. Because they can be built to a greater height, they are stronger than rolled girders and can be used to span longer distances, often more than 300 feet.

Passaic Avenue Bridge
over the Passaic River
Cities of Garfield & Passaic
Built 1898

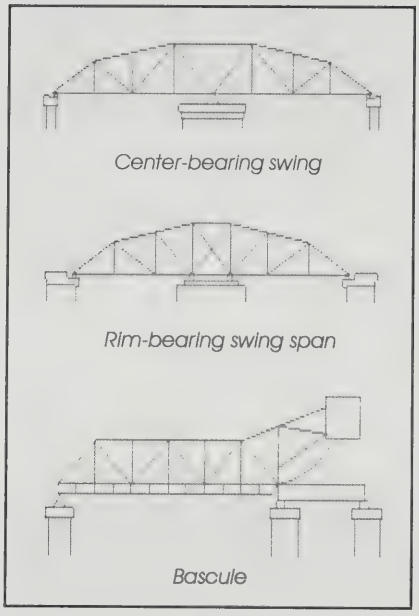
(11)

This three-span through girder bridge carries Passaic Avenue over the Passaic River. The bridge is composed of riveted plate girders and has ashlar abutments and piers. At 233 feet in length, the Passaic Avenue Bridge is a long example of its type in New Jersey. Built in 1898, the structure was designed by the Wise and Watson Company of Passaic and erected by the F.R. Long Company.

Located on the Bergen-Passaic County line, the Passaic Avenue Bridge is significant as the earliest documented multi-span girder bridge in Bergen County.

Movable Bridges

Because of the importance of both water and land transport in Bergen County, movable spans were constructed over the Hackensack and Passaic Rivers from the eighteenth century onward. These movable bridges permitted the use of rivers for shipping while maintaining important land connections between waterfront communities. Although longer spans exist to the south, in Hudson and Essex Counties, Bergen is home to a number of technologically significant movable spans, representing two distinctive types:



Movable bridge types
from Virginia Transportation Research Council

- *Swing spans* have a central pier upon which the movable structure pivots. When closed, the swing span's ends rest either on piers or on abutments, depending on the length of the bridge. Swing spans can be further classified as center bearing or rim bearing, depending on the type of bearing mounted on the center pier. Bergen County's historic swing spans include New Bridge (#12), De Jessa Memorial Bridge (#13), Slomiany Memorial Bridge (#14), and Dillard Memorial Bridge (#15).
- *Bascule* bridges are drawbridges that lift the span upward using a counterweight. These bridges are further identified as either single-leaf, having one movable section, or double-leaf, with two movable sections. Several different operating mechanisms are employed to move the leaf, including a simple trunnion and a Strauss or heel trunnion. Bergen County has two historic bascule bridges, the 8th Street Bridge (#16) and the US Route 46 Bridge (#17).

(12)

New Bridge
over the Hackensack River
New Bridge Landing
River Edge Borough
Built 1895

This bridge is known as "New Bridge," a name given to this crossing of the Hackensack River in the eighteenth century to distinguish it from "Old Bridge," located upstream. Built in 1895, the existing bridge is the most recent of several movable spans constructed at this location. The bridge is an iron Pratt truss with a rim-bearing swing mechanism. The bridge rests on a turntable atop a pier at the center of the river. The turntable's swing mechanism, although no longer functional, is intact and is comprised of gears and spaced wheels. The King Bridge Company of Cleveland built this structure.

Although it no longer carries vehicular traffic over the Hackensack River, New Bridge is significant as the oldest highway swing bridge still standing in New Jersey. The structure is individually listed on the National Register of Historic Places.

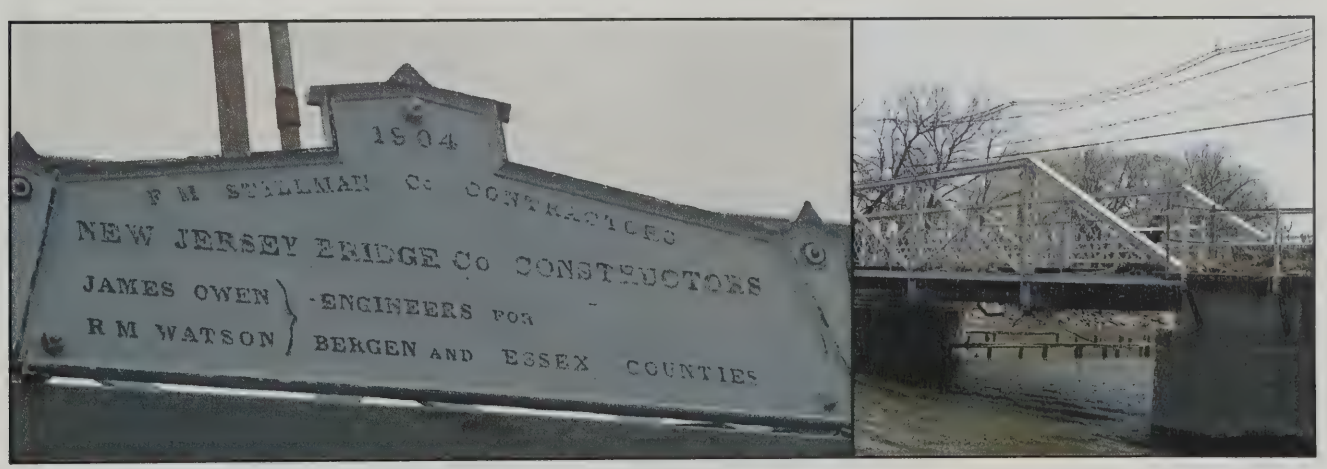
De Jessa Memorial Bridge
Park Avenue
over the Passaic River
Lyndhurst & Nutley Townships
Built 1904-1905

(13)

Also known as the Avondale Bridge, this structure crosses the county line between Bergen and Essex. The three-span bridge was built in 1904-1905. The structure has a central Warren through truss swing span flanked by two Warren pony truss approach spans. The bridge has both pinned and riveted connections.

The De Jessa Memorial Bridge was designed jointly by the Bergen and Essex County Engineers and built by the New Jersey Bridge Company of Manasquan. The company built numerous bridges in New Jersey and throughout the northeastern United States between 1890 and 1907. This structure may be the company's largest documented bridge in New Jersey.

This bridge is significant because it reflects the state of design knowledge at the time of its construction. The bridge was renamed in honor of Joseph C. De Jessa, a U.S. Marine and the first Lyndhurst native killed in Vietnam. The structure underwent a major rehabilitation in 1984.



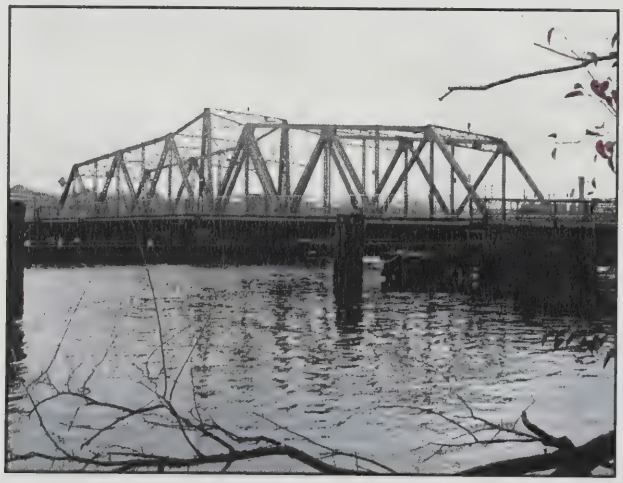
From left, sign, DeJessa Memorial Bridge, Lyndhurst to Nutley (#13); New Bridge, River Edge (#12)

(14)

Slomiany Memorial Bridge
Gregory Avenue
over the Passaic River
Wallington Borough &
City of Passaic
Built 1906

The Slomiany Memorial Bridge is a rim-bearing swing span. Built in 1906 by the Owego Bridge Company, this through truss structure crosses the county line between Bergen and Passaic. In 1985, the operating machinery and operator's house were removed, rendering it no longer functional; however, the key identifying elements of the bridge, including its trusses and central pier with the swing mechanism, remain intact. The bridge is located at the site of the Acquacknonk Bridge, which was burned by George Washington's troops in November 1776 as they retreated from the British.

This structure is significant as a representative example of a rim-bearing swing span in Bergen County. The bridge was named after Kazimierz H. Slomiany, a Wallington native killed while serving in the U.S. Army in Vietnam.



(15)

Dillard Memorial Bridge
Court Street
over the Hackensack River
City of Hackensack
Built 1908

The Dillard Memorial Bridge is a center-bearing, Warren through truss swing span. The bridge has a concrete substructure and steel deck girder approach spans. The bridge was erected in 1908 by the F.R. Long Company, a regionally important bridge-building firm based in Hackensack. The F.R. Long Company also built the Lake Avenue Bridge in Midland Park (2) and the Passaic Avenue Bridge in Garfield (11).

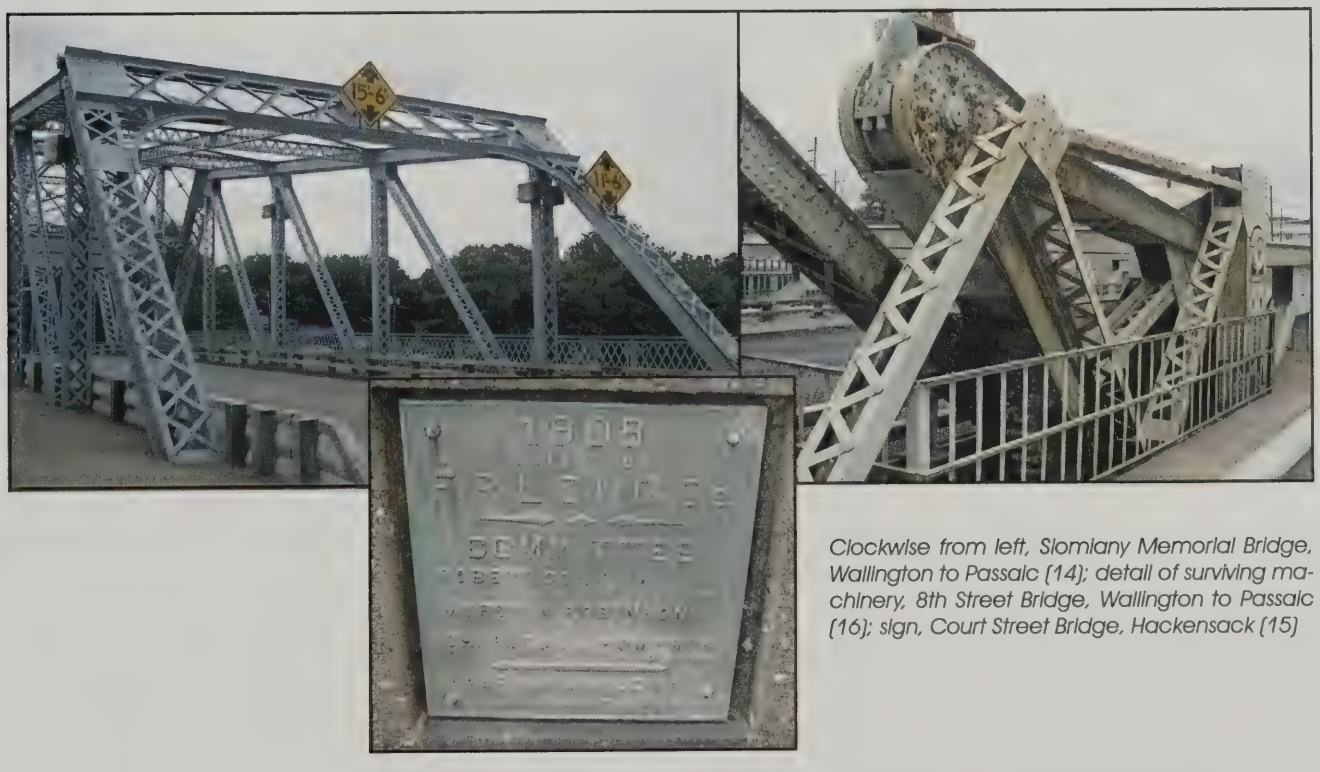
This bridge is significant for its association with the F.R. Long Company and as a rare surviving operational swing span in the county. The bridge was dedicated to the memory of Harold J. Dillard, the first Hackensack native killed in Vietnam.

8th Street
over the Passaic River
Wallington Borough &
City of Passaic
Built 1915

(16)

The 8th Street Bridge spans the Passaic River, connecting Bergen and Passaic Counties between Wallington and Passaic. The bridge is a three span, single leaf bascule structure; the spans are comprised of riveted Warren pony trusses. Built in 1915, the structure employed a Strauss overhead articulated counterweight mechanism. J.B. Strauss invented this type of pivoting counterweight linkage and patented the design in 1905. The Strauss bascule bridge was the most popular movable bridge type in the country during the early twentieth century, although only five remain today in New Jersey.

This bridge is significant as a rare surviving example of a Strauss bascule bridge in New Jersey. The 8th Street Bridge was fixed in the closed position in 1976 and its operator's house and machinery removed soon thereafter. The overhead counterweight was removed after 1993.



Clockwise from left, Slomiany Memorial Bridge, Wallington to Passaic (14); detail of surviving machinery, 8th Street Bridge, Wallington to Passaic (16); sign, Court Street Bridge, Hackensack (15)

(17)

US Route 46 Bridge
over the Hackensack River
Little Ferry Borough
Built 1934

This double-leaf bascule deck girder bridge carries US Route 46 over the Hackensack River, railroad tracks, and a local roadway. The bridge has a concrete substructure and sixteen approach spans. Four octagonal concrete towers are located at the corners of the bascule span; two of the towers are gate tenders' houses, one contains the bridge's operating mechanisms, and one is used for storage. The structure was designed by Waddell and Hardesty Consulting Engineers for the New Jersey State Highway Department. This engineering partnership was notable for its innovative designs; its bridges, constructed during the 1920s and 1930s, are located throughout the United States.

The US Route 46 Bridge is significant for its associations with Waddell and Hardesty and as an example of an uncommon bridge type. It is the only remaining operational bascule bridge in Bergen County.

(18)

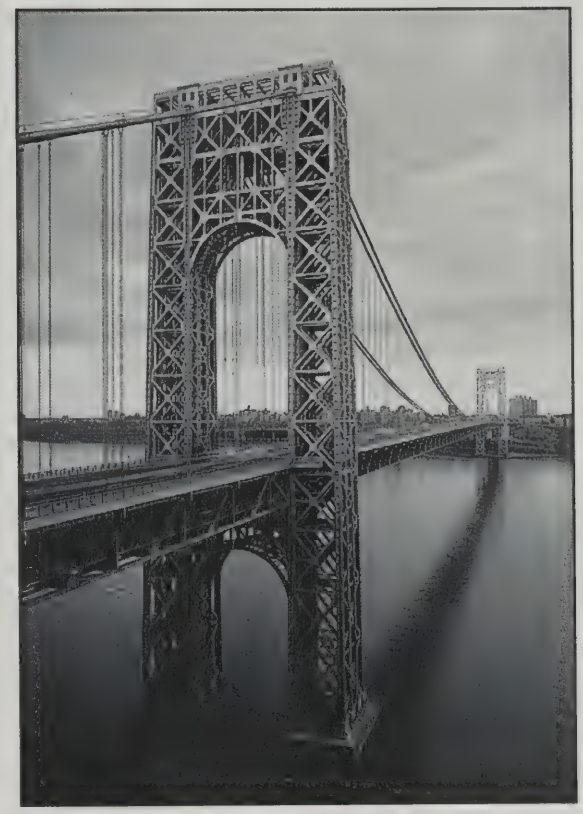
NJ Route 3 Bridge
over the Passaic River
Rutherford Borough & City of Clifton
Built 1949

The NJ Route 3 Bridge is a seven span, double-leaf bascule over the Passaic River. The structure has four leafs, two on each side, which are structurally linked and operated together. The four leafs were necessary because of the width of the structure, which carries three lanes of traffic in each direction. The operators' houses are constructed in the Moderne style. The structure was designed by Parsons Brinckerhoff for the State Highway Department.

This bridge is a significant example of a paired double-bascule structure and is also significant for its Moderne design. Due to a decrease in river transportation, the bridge has not opened since the late 1980s.

The George Washington Bridge & Its Approaches

> *The George Washington Bridge over the Hudson is the most beautiful bridge in the world. Made of cables and steel beams, it gleams in the sky like a reversed arch... It is the only seat of grace in the disordered city.*
>
> Modernist architect Le Corbusier, 1947



George Washington Bridge, Fort Lee to New York City Built 1931

The George Washington Bridge [GWB] is unquestionably the most dramatic and remarkable of Bergen County's historic bridges. Spanning 4,760 feet across the Hudson River from Fort Lee to Manhattan, the GWB was the longest suspension bridge in the world when it opened in 1931 and is the thirteenth longest today. The American Society of Civil Engineers named the GWB a National Historic Civil Engineering Landmark in 1981.

The GWB is a steel suspension bridge. Although steel suspension bridges were not introduced until the late nineteenth century, the engineering principle from which they evolved was developed by cultures in Africa and South America centuries ago. These primitive bridges were constructed of twisted vines forming cables tied high in the trees; the walkway was then hung from these cables. Because of the heavier loads carried by modern bridges spanning much longer distances than these primitive structures, this basic form was adapted by passing the cables over tall towers and anchoring them in rock or concrete on the riverbank. As with the primitive rope bridges, the roadways of suspension bridges are hung from the cables, which are comprised of twisted steel wire.

Construction of the GWB, which was designed by the Port Authority's Chief Engineer Othmar H. Ammann, began in 1927. The steel towers rise more than 600 feet high, and the four steel rope cables each measure one yard in diameter. The original design included stone cladding on the towers; however, the cost was deemed too high, and the towers were left uncovered. When it opened to traffic in 1931, the bridge was remarkable for its length—more than double that of any existing suspension bridge at the time—and for its deck, which was the first suspension bridge deck not to use stiffening trusses in its construction. Ammann designed the GWB with an eye toward expansion, allowing for the addition of the lower deck in 1962.

The opening of the GWB over the Hudson River in 1931 significantly impacted transportation in Bergen County. Engineers for the State Highway Department faced the challenge of providing vehicular access to and from the bridge within an existing network of highways and local roads. They also sought to avoid grade crossings of the

roadways, which would slow traffic unnecessarily. As a result, a series of overpasses and ramped breakouts were employed to carry traffic onto and off of the GWB.

Among the engineering solutions utilized to funnel traffic onto the bridge, the three-tier grade separation near the western limits of the approach was technologically the most significant. The intersection was comprised of two bridges over a local roadway, which later became the I-95 ramp when the lower deck was added to the GWB. The uppermost bridge structure carried two eastbound lanes of US Routes 1, 9, and 46 over NJ Route 4, at center, which itself spanned the I-95 ramp.

(19)

This three-tier structure has been altered several times since its construction in 1931. The most important alteration occurred in 2000, when the upper bridge carrying US Route 1, 9, and 46, was demolished. The photograph at left shows the three-tier intersection after the replacement of the upper bridge, which was an encased multi-girder structure built on a horizontal curve. The NJ Route 4 Bridge, a single-span, encased thru girder, remains. This structure is a contributing resource within the National Register-eligible Route 46 Corridor, which extends from the GWB to Grand Avenue in Ridgefield Borough.

From left, view from New Jersey tower and view toward Manhattan, George Washington Bridge, Fort Lee to Manhattan

For Further Information

The historic bridges of Bergen County employ a variety of materials and methods of construction, comprising a unique and functional historic resource enjoyed by residents and visitors alike. Their preservation presents a great challenge, as these aging structures often must be replaced to accommodate modern traffic needs.

The primary resource for information regarding historic bridges in New Jersey is the statewide bridge survey, completed by A.G. Lichtenstein & Associates, Inc., in 1994. The survey report and individual bridge data are available on the New Jersey Department of Transportation website, http://www.state.nj.us/transportation/works/environment/HistBrIntro.shtm.

Many books have been written about bridges and bridge design. Those published in the nineteenth and early twentieth centuries are invaluable for researchers interested in specific historic bridge types. For readers interested in more general treatments of historic bridges in New Jersey and elsewhere, a brief list of resources published in the past thirty years follows. A list of useful websites is also included. While neither list is comprehensive, they both provide a starting point for those interested in learning more about historic bridges.

Books

David P. Billington, *The Tower and the Bridge: The New Art of Structural Engineering* (Basic Books 1983)

Eric DeLony, *Landmark American Bridges* (Bulfinch Press 1993)

Jaques Heyman, *The Masonry Arch* (Ellis Horwood 1982)

Donald Jackson, *Great American Bridges and Dams* (Preservation Press 1988)

Terry L. Koglin, *Movable Bridge Engineering* (John Wiley & Sons 2003)

Michael Lapinski, *Road and Bridge Construction Handbook* (Van Nostrand Reinhold Co. 1978)

Steven M. Richman, *The Bridges of New Jersey: Portraits of Garden State Crossings* (Rutgers University Press 2005)

David Weitzman, *Traces of the Past: A Field Guide to Industrial Archaeology* (Charles Scribner's Sons 1980)

Web Sites

Historic Bridge Foundation, www.historicbridgefoundation.com

Historic Bridges of the U.S., www.bridgehunter.com

Bridge Basics: Spotter's Guide, http://www.pghbridges.com/index.htm (Allegheny County, Pennsylvania)

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